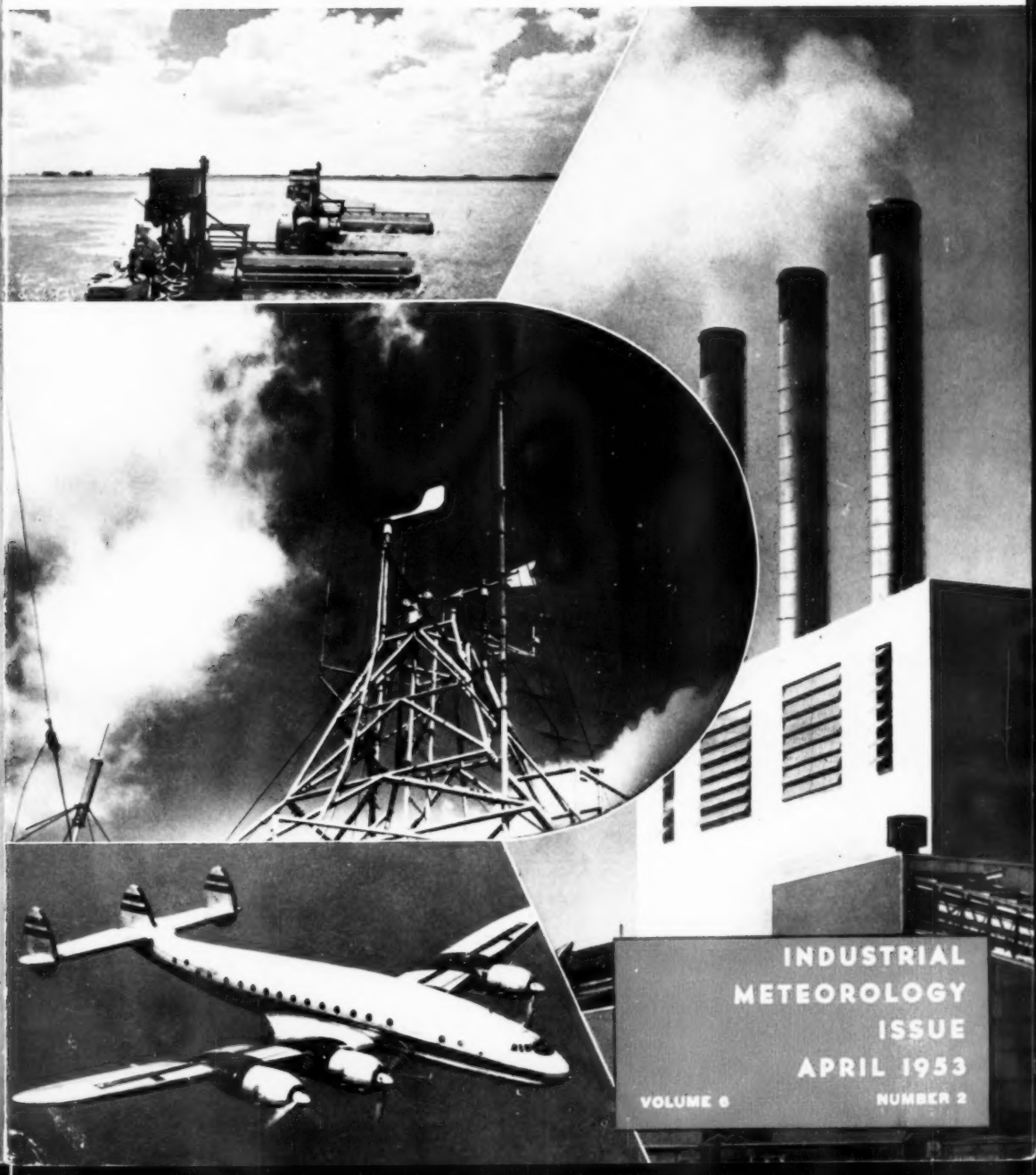
Weatherwise



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APRIL 1953

VOLUME 6 NUMBER 2

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Foreword

HON. ROBERT B. MURRAY, JR.
Under Secretary of Commerce for Transportation

AS a former student of that famous professor of climatology, Robert DeCourcy Ward of Harvard, I have watched with interest the rapid developments that have taken place in meteorology since my college days.

I am especially pleased to note the progressive steps now being taken by meteorologists and business leaders—as evidenced by this special issue of Weatherwise—to increase still further the practical benefits that applied meteorological services can bring to industry.

To understand how weather affects business you do not need to examine stacks of annual reports, run down columns of statistics, or study intricate graphs relating the ups and downs of business to the occurrences of precipitation. An understanding of the importance of weather in industry is found daily in the lives of millions of our people.

The man who starts up a business of pushing a banana cart around town soon finds out how weather can affect his prosperity. After a day of bright sunshine he happily pushes an empty cart homeward. But after a day of heavy rain he slowly plods along counting all the bananas he did not sell. This curb-side banana merchant may not know that the total annual business of the fruit production and fruit marketing industry amounts to billions of dollars and gives employment to over a million people. But he does know how weather can affect the prosperity of one man in the fruit business.

Most meteorologists have heard similar personal accounts of how the small businessman has learned about the effects of weather on his business through vivid profit or loss experiences. The next step, of course, in this businessman and weatherman partnership is to find out how applied meteorology can be better used to increase the profits and to reduce the losses resulting from weather conditions.

It seems to me that there has developed a wider understanding among members of industry as to the real nature, extent, and cause of losses due to weather. And the trend to further cooperation between private meteorologists, industrial organizations, and the Weather Bureau should be good news indeed to all business men who are familiar with the caprices of nature.

The services of the Weather Bureau are one set of many services which the Department of Commerce offers to private industry and to the general public. Our desire is to do everything possible within our means to keep industry informed so it, in turn, can use this information for plans and in action.

"SOME PEOPLE ARE WEATHERWISE BUT MOST ARE OTHERWISE"—BENJAMIN FRANKLIN

WEATHERWISE

THE MAGAZINE ABOUT WEATHER

DAVID M. LUDLUM, *Editor*
HENRY W. BULKLEY, *Associate Editor*
HANS H. NEUBERGER, *Technical Editor*
ERIC SLOANE, *Art Director*

SPRING MEETING OF AMS

The 122nd National Meeting of the American Meteorological Society will be held in Washington, D. C. on April 29–May 4, 1953. As in the past, the annual fixture on the meteorological calendar will be sponsored by the District of Columbia Branch of the AMS. The technical sessions will be held in the auditorium of the U. S. National Museum, Constitution Avenue at 10th Street.

Highlighting the meeting will be a panel discussion of the Jet Stream on Friday afternoon, May 1. Topics for other sessions are: Wednesday morning, April 29—Meteorological Instruments and Observations; Wednesday afternoon—Precipitation; Wednesday evening—Radar Meteorology; Thursday morning, April 30—Climatology; Thursday afternoon—Physical and Dynamic Meteorology; Friday morning, May 1—Synoptic Meteorology.

Joint meetings with the Fluid Dynamics Division of the American Physical Society and the Meteorology Section of the American Geophysical Union are scheduled for Saturday, May 2, and Monday, May 4, respectively.

The annual dinner of the AMS on Thursday evening, April 30, will take place at the National Press Club and will have Dr. George Gamow of George Washington University as guest speaker. Mr. A. K. Showalter of the U. S. Weather Bureau will act as toastmaster. Dinner tickets will be $3.50 per person.

Mr. Conrad Mook, head of the District of Columbia Branch of the AMS, will serve as general chairman of the meetings. Advance reservations for the dinner should be made by mail in writing to L. E. Brotzman, U. S. Weather Bureau, Washington 25, D. C.

Vol. 6, No. 2 April, 1953

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The New Science of Industrial Meteorology

HORACE R. BYERS, *President, American Meteorological Society*

TWENTY–FIVE years ago meteorology was a Government monopoly. Commerce and industry in the United States took care of the weather factors in their operations by making use of information given out to the general public by the Weather Bureau. In ventures where the weather risk weighed heavily, a more or less weatherwise representative of the organization involved would keep in personal touch with local Weather Bureau officials. This method seems to work fairly well for some businesses and industries even today.

As commercial air travel developed in the late 1920's, the budding airlines began to see that their operations would need a closer look at the weather than was afforded by daily talks with the Weather Bureau and by scanning forecasts and reports. The predecessor companies of Trans-World Airlines and Western Airlines began to hire their own staffs of meteorologists, and gradually the other large airlines built up private meteorological units. The Government monopoly ended.

The direct use of private meteorological services in other industries was slow in coming. Like some other businesses and professions, the business of industrial meteorology —the selling of weather science to a variety of customers—started under doubtful circumstances. Some seemingly hard-headed businessmen paid money for sheer quackery worked on them by pseudo-scientists eager for a "fast buck." Some of these characters still are at work today.

Modern legitimate industrial meteorology was pioneered in the early 1930's largely by Irving P. Krick, then head of the meteorology course at the California Institute of Technology. Backed by the famous Robert A. Millikan, then president of that institution, who foresaw great things for this service, Krick first went into the business of forecasting for the exact conditions of light and cloud needed by the motion picture industry for outdoor scenes. The business was profitably pushed into other parts of commerce, industry, and agriculture. At the close of World War II the American Meteorological Society took a hand in this field believing that in this way it could help open up new horizons for the great body of top-notch, war-trained, young meteorologists and at the same time help industry better meet the demands of the post-war scramble to market civilian goods. We of the Society feel that much of the recent growth in this field is due to our activity.

Why is industrial meteorology needed? What good can it do? Anyone old enough or not too feeble to use a telephone can get a weather forecast in most places at any time of the day or night. You can even call the Weather Bureau, talk personally to the forecaster, if you insist, tell him your problem and get a first-rate answer without charge, except for the telephone call. If the weather happens to be bad, however, you may not even be able to reach the Weather Bureau switchboard, the calls are coming in so fast. The Weather Bureau has too many customers to take care adequately of individual needs. The private industrial meteorologists, with only a few clients whose special wants are always kept in mind, can really be a life-saver both literally and figuratively. A businessman can arrange things so he will not have to worry about the weather, giving the industrial meteorologist the job of letting him know when weather-risk situations may arise and of giving a plan of action.

Weather forecasts and warnings are not the only things the meteorologist has for sale. He can guide day-to-day operations and future planning of a business so as to make the best use of the weather at hand. Much planning can be improved by taking into account the weather probabilities based on past data, where no true forecast is involved. Studies of the climate of different spots are needed for the location of buildings and yards, construction work, the solution of distribution problems, sale of seasonable goods, and a host of other problems.

(*Continued on page 57*)

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A windjammer, lazy in a summer breeze—a flat top, knifing through a sullen sea . . . have this in common . . . Times Facsimile equipment . . . for the speedy reception of weather charts and other important information. ★ ★ ★ ★ ★ ★ ★ The ship illustrated is "The Eagle", a full rigged 295 ft. Coast Guard training bark based at the U. S. Coast Guard Academy in New London, Connecticut.

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The United States Weather Bureau and Industry

FRANCIS W. REICHELDERFER, *Chief, U. S. Weather Bureau*

A FEW years ago a survey was made of the uses of weather information to business and industry in the United States. There was an attempt to assign monetary values to the savings or profits realized through practical applications of daily weather reports, forecasts, storm warnings, and climatological data. Business organizations and industrial corporations who reported in the survey that they make regular use of weather information were asked to estimate the value of this information to them. Marketers of fresh produce who act on weather forecasts to prevent spoilage in hot weather or freezing in cold weather were asked to estimate how much greater their losses would be annually if weather information were discontinued except for what they might themselves observe locally. Construction companies were asked to estimate how much greater their costs would be from heavy rain or snow if they had no forecasts of these conditions on which to take precautionary measures. Various processing industries affected by temperature, humidity, and other weather conditions gave monetary estimates on their losses in efficiency if they had no weather information except what they could observe or measure locally.

Although the survey did not attempt to include all of American business and industry, the sampling was sufficiently broad and representative to give an indication of the order of magnitude of weather service values, but the results were never published in detail because the figures were so large they would undoubtedly have been controversial! The total for the United States ran into ten figures annually. The survey served the purpose, however, of reminding us again how weather and climate affect our daily lives and our means of livelihood. It showed that the value of weather information to the "consumer" represents an enormous sum, and weather resources and meteorological information are very important factors in national income.

Many of the uses of weather information are "hidden." Weather reports and forecasts and, in many cases, climatological knowledge are such a regular part of business plans and operations that they are taken for granted and their importance is forgotten. The Weather Bureau has collected statements on the many different uses of weather information in business and industry and these run all the way from flight forecasts for *A*viators to rainfall and temperature data for *Z*innia growers. Among the 101 different uses many were relatively unknown and these point to a probable huge backlog of potential uses in business and industry yet to be developed.

The primary job of the Weather Bureau in its capacity as the national weather service is to provide the basic data of weather and climate, the daily forecasts, and the warnings of severe weather conditions required for general public welfare and for the business community as a whole. The Bureau cannot provide specialized services for individual business concerns although in large industrial areas it endeavors to include in its daily reports and forecasts those weather elements of special interest to major branches of the local business economy. During the past ten years there has been much progress by industrial meteorologists and private meteorological consultants in developing new applications in meteorology and climatology for various different business enterprises. Through publication of illustrations of these services and through cooperation in bringing together the consultant meteorologist and the interested industrial enterprise whenever possible, the Bureau endeavors to encourage developments for the good of applied meteorology as a whole.

Industries of one kind or another have use for practically every kind of weather information the Bureau collects. The statutes have designated certain major fields for which meteorological services are to be provided by the Bureau. These include agriculture, aviation, and shipping. But basic meteorological facilities and communications required for weather reports and forecasts for these fields are closely inter-related. Although it is im-

practicable and uneconomical to draw a sharp distinction between the meteorological organization for one or the other of these, the Bureau has designated branches comprising an Aviation Weather Service, an Agricultural Meteorological Service, a Marine Meteorological Service, and a Forest Fire Weather Warning Service in addition to the general weather service. In many cases, the same field offices and employees act in two or more of these service capacities. For the most part all of the activities of the Bureau serve business and industry in one way or another, while at the same time serving the general public. In collection of basic weather data, the Bureau serves also the military arms of the government and all others interested in the weather and climate of the United States.

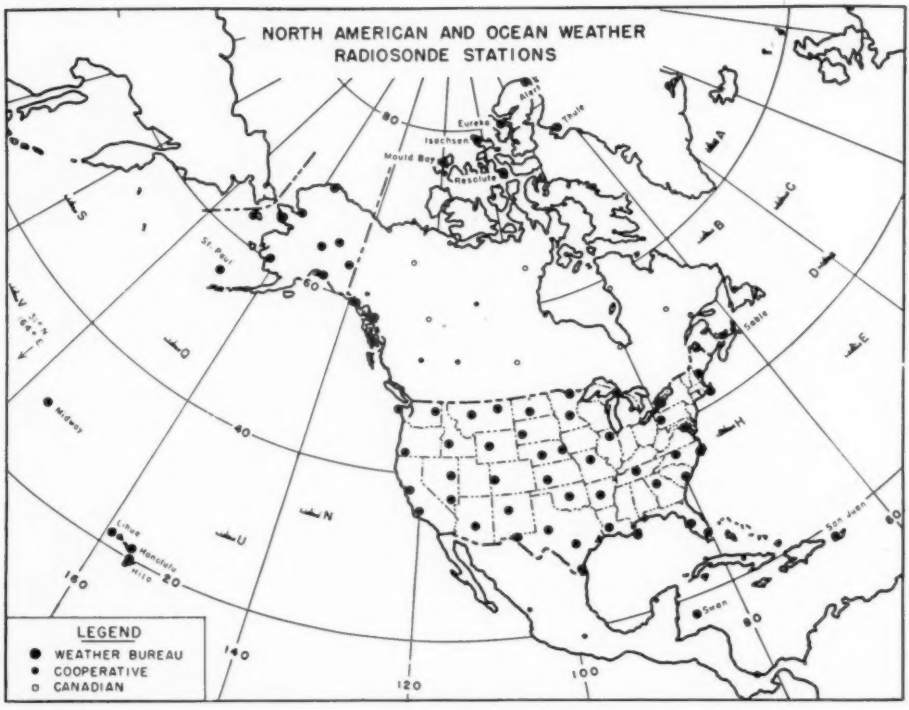
The scope of the job of reporting and forecasting all of the different kinds of weather of significance to the people of the United States is evidenced by the *average* number of storms and weather changes each year. There are:

8 Hurricanes
28 Coastal and Great Lakes Storms
30 Cold Waves, or blizzards, heavy snowfalls, severe freezes
70 Disastrous floods
300 Tornadoes or other severe local storms
5,000 Forest Fires of serious proportions
500,000 More or less—local weather changes, that is, daily and sometimes hourly changes in weather in the many thousands of different localities in the United States.

In order to provide forecasts and warnings for the public and for the business community in general, the Bureau has to make weather observations, collect reports, and issue forecasts and warnings that number approximately as follows each year:

500,000 basic synoptic weather observations and reports
6,000,000 hourlies and specials for aviation
22,000,000 climatological observations
190,000 specific forecasts for agriculture, marine shipping, etc.

(*Continued on page 62*)



The Gold Mine at Asheville

JOHN A. COPELAND, *U. S. Weather Bureau*

THE National Weather Records Center, located in the Grove Arcade Building, Asheville, N. C., was organized in January 1952. This organization was planned to bring into being a long-felt need to centralize, insofar as is practicable, the widely scattered weather records of the U. S. Government and the available facilities for processing such records. In this center of pooled weather records and processing facilities, including about 200 million weather punched cards, there is assembled the greatest collection of weather records and weather data processing facilities the world has ever seen. As far as the Weather Bureau is concerned, the center at Asheville is a logical organization for the accomplishment of those projects of a national scope which the Bureau is obligated to perform in the public interest.

The National Weather Records Center, however, also represents a resource of vast potential for the solution of special industrial climatological problems; increasingly, these resources are being called upon to furnish analyses of important special problems involving weather factors. Climatology is to the long-range industrial planner what the weather forecast is to the day-to-day industrial operator. The Weather Bureau, engaged as it is in rendering a public service, cannot undertake on public funds the solution of individual industrial climatological problems of a specialized nature. Such specialized problems must be solved at the expense of the industries involved. The Weather Bureau can only make its data, its facilities, and its "know-how" available at cost to the staff specialists or private consultants engaged by the industries involved. The staff specialists or consultants for the industry concerned should (a) define the problem, and (b) determine the relationship of weather factors to the problem. The Weather Bureau, then, using its available weather punched cards (which have been prepared as an operational necessity in accomplishing the Bureau's legally approved public service program), and its machine facilities and staff, perform at cost the necessary data processing at the National Weather Records Center to obtain the required analyses of weather records.

What is needed most at this stage of the

(*Continued on page 57*)

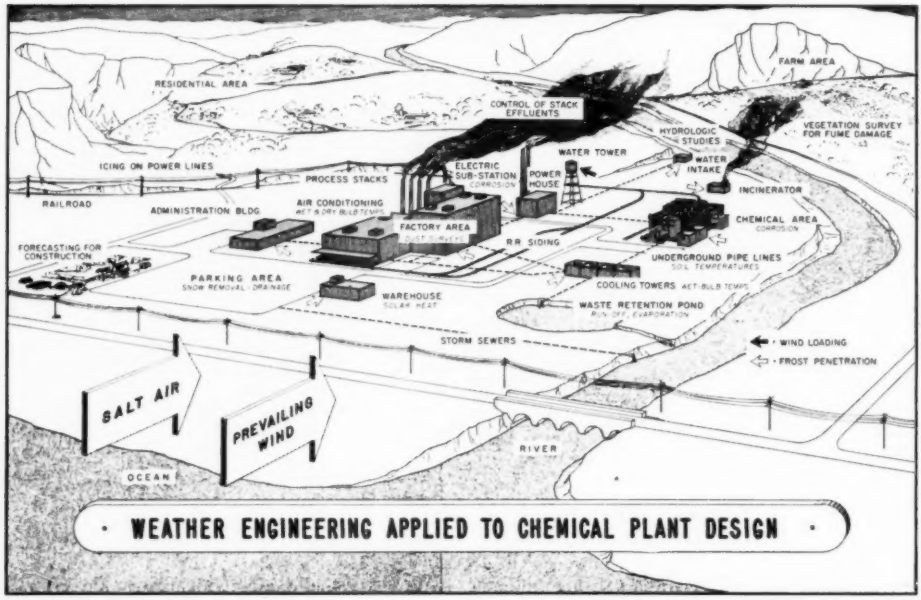
Meteorology in a Chemical Industry

GEORGE F. COLLINS, *Engineering Department, E. I. du Pont de Nemours & Co.*

THE importance of meteorology to E. I. du Pont de Nemours & Co. was first realized in 1943 when it was engaged in building the Hanford Engineering Works in Washington for the Atomic Energy Commission. A group of meteorologists was assigned the task of predicting the dispersion of stack gases and controlling atmospheric pollution for this project. In 1946, C. A. Gosline, who had been at Hanford, undertook a study to evaluate the application of meteorological skills to company activities; as a result of this study, meteorologists were assigned to the Engineering Department in 1948. Since that time, the group has increased to seven professional meteorologists, all having engineering training in addition to their meteorological background.

The meteorologists are assigned to the Water, Waste, and Weather Consultants Group in the Engineering Department because the major portion of their work is concerned with the control of atmospheric wastes. The meteorologist assists in proper site selection and gives advice on location and size of stacks for new plants. It is very important that the atmospheric wastes of the entire plant be considered as a unit problem. The present "state of health" of the area is determined by vegetation and air sampling surveys, and then the combined effect of all the new stacks must be added to already existing conditions. A thorough knowledge of microclimate and terrain is essential, for with this necessary data stack heights can be determined theoretically from the Bosanquet and Pearson formula for the dispersion of stack gases. Knowing the kind and amount of effluent issuing from a stack, the height is calculated to prevent excessive ground-level concentrations of contaminants occurring during unfavorable dispersion conditions. This formula has been tested in the field by du Pont engineers and the values of the dispersion parameters determined with a known accuracy.

In the case of short stacks where the geometry of adjacent buildings or terrain are determining factors in smoke-plume behavior,



recourse has been made to tests in a low-speed wind tunnel. The Consolidated Edison Wind Tunnel at New York University has been used for this purpose. A model of a new synthetic fibers plant was recently tested in this tunnel to see if fumes from boiler stacks would recirculate into fresh air intakes of the spinning rooms. Experiments showed that with relatively short stacks, regardless of wind conditions, recirculation was a very remote possibility. With the stacks as first designed, however, the gases went directly into the air intakes of a lower laboratory building some distance downwind. Prior to the tunnel tests, such a possibility never occurred to the engineers. The situation was remedied by adding 25 feet to the stack heights. All problems, however, cannot be solved by merely extending the stacks. Some type of collector such as filter, bag, cyclone, or scrubber may be required, or it may be necessary to alter the chemical operation to maintain minimum emissions.

An ever-increasing amount of work is being done under two other categories—applied climatology and weather forecasting.

Climatic factors enter into chemical operations in many ways. Design of air conditioning equipment, cooling towers, storm sewers, waste retention basins, foundations, all require climatological knowledge. Design values are obtained from frequency distributions of the common climatological elements.

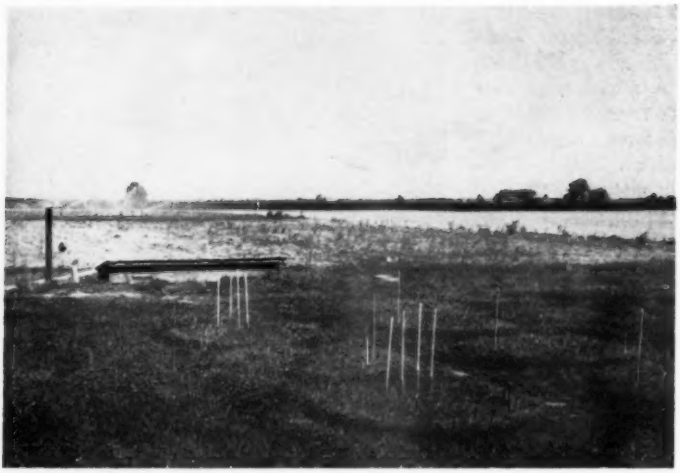
Stack sampling to determine fly-ash collector efficiencies is one of the jobs of an industrial meteorologist.

Microclimate surveys play an important part in site selection and plant design.

From time to time research is undertaken to study some particular phase of climatology. One project concerns the pattern of soil temperatures at various depths, yielding information valuable for determining needed pipeline insulation and probable frost penetration. Still another project concerns basic wind loads on company structures in which wind variation with height and gust factors were investigated.

In most climatological studies, use is made of the extensive punch card facilities of the U. S. Weather Bureau. On occasion it is known that the data is not representative for the location in question because of differences in terrain and exposure or distance from the observation point. In such cases a climatic station is erected on the site employing a regulation shelter and instruments. Records have also been taken with a portable recording anemometer. These short-term observations are then correlated with the longer period Weather Bureau records.

The latest service offered by the company meteorologists is that of short-range weather forecasting, an activity initiated in 1951. Thus far, such service has been confined to one large construction project where on-the-site weather service has proved economical by extending and interpreting Weather Bureau services to fit the needs of construction activities.



A battery of six evapotranspirometers was established at Seabrook Farms in 1947 and has been operating continuously since that time to yield valuable microclimate data.

Applied Climatology at Seabrook Farms

JOHN M. SEABROOK, *Executive Vice President, Seabrook Farms Company*

UNDER the leadership of my father, Seabrook Farms has grown from 57 acres to an area of 20,000 acres. From its beginning as a fresh-produce operation, it has become the world's leading integrated, industrial, farming enterprise: raising vegetables and processing, quick-freezing, storing, and distributing them throughout the eastern part of the country. About 14 percent of the United States annual pack of frozen vegetables comes from Seabrook Farms.

My grandfather and father were early aware of the adverse effects of summer drought on crop yields, and nearly 50 years ago began a program of supplementary irrigation. The area under irrigation at Seabrook has increased through the years and now amounts to about 2,000 acres. Some of the irrigation equipment that my father installed long ago is still in operation.

In the last 20 years a genuine revolution in agriculture has been brought about by new agricultural implements and machines, new insecticides and fungicides, new methods of maintaining soil fertility and preventing erosion, better seed, and new strains and varieties of plants. Although every farmer knows that weather and climate are both important factors in agriculture, little credit can be taken by the meteorologist or the climatologist for recent agricultural progress.

I have discovered that meteorologists usually think only of weather forecasting when suggesting the applications of meteorology to agriculture. Several private meteorologists have proposed that we should set up an office to make our own weather forecasts. There are occasions when harvest crews start work in a field only to be rained out, and then factory workers must be sent home too. We have investigated various weather services and have subscribed to some of them. But we have learned by experience that neither the weather forecasts which these services provide, nor the regular Weather Bureau forecasts are sufficiently detailed or reliable to be of much use. There are many occasions where we once thought we needed weather forecasts, but we now realize that we do not really need them, since there are other ways of analyzing our weather problems which give us better control over them.

About five years ago we joined with the Johns Hopkins University in setting up a laboratory at Seabrook Farms to study agricultural climatology. Some of the work of the laboratory has already been described to readers of WEATHERWISE (see April 1951,

p. 27). We have established a network of more than 50 weather stations in the area of Seabrook Farms to get at local variations in climate. The Laboratory of Climatology has been conducting detailed work on drought and the moisture factors in agriculture. The first battery of evapotranspirometers in the United States was installed at Seabrook Farms, and now others have since been established elsewhere in the United States and in several other countries. The Seabrook laboratory serves as the clearing house for the data which come from Canada, Ireland, Nigeria, Belgian Congo, Hong Kong, Trinidad, and elsewhere. Although these observations add to the general store of climatological knowledge, they are also of practical value in Seabrook Farms, having helped in the solution of the problem of irrigation scheduling.

The big problem in irrigation is to know when to irrigate and how much water to apply. Our irrigation practice at Seabrook Farms in the past has not been very scientific because we did not know these things. The climatological studies have given us a solution that has already boosted the yields of some crops. We believe that as soon as we have succeeded in fitting this irrigation technique into our farming operations, we will have substantial increases in crop yields.

Obviously, if rainfall were not deficient at any time during the growing season, there would be no need for irrigation. For that reason we have followed the literature on cloud seeding and artificial rain-making with very great interest in the hope that we could get the needed water to the crops with less effort and expense. We have conducted some inconclusive experiments on the dry ice technique of cloud seeding. We do not feel competent to enter into the controversy on rain-making that is now raging in the United States, but we are not optimistic about being able to make practical use of the techniques at Seabrook Farms. During the periods of summer drought, the conditions required for artificial rain-making do not exist; therefore, we should not expect to be able to produce rain at the times we need it. Furthermore, we do not believe that we could make the rain

(*Continued on page 59*)

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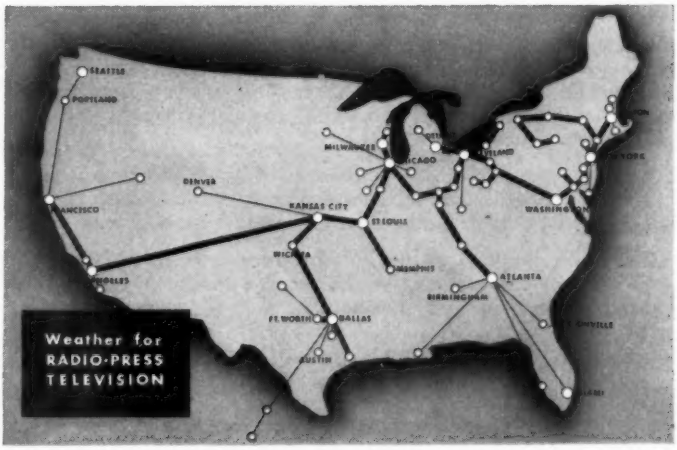

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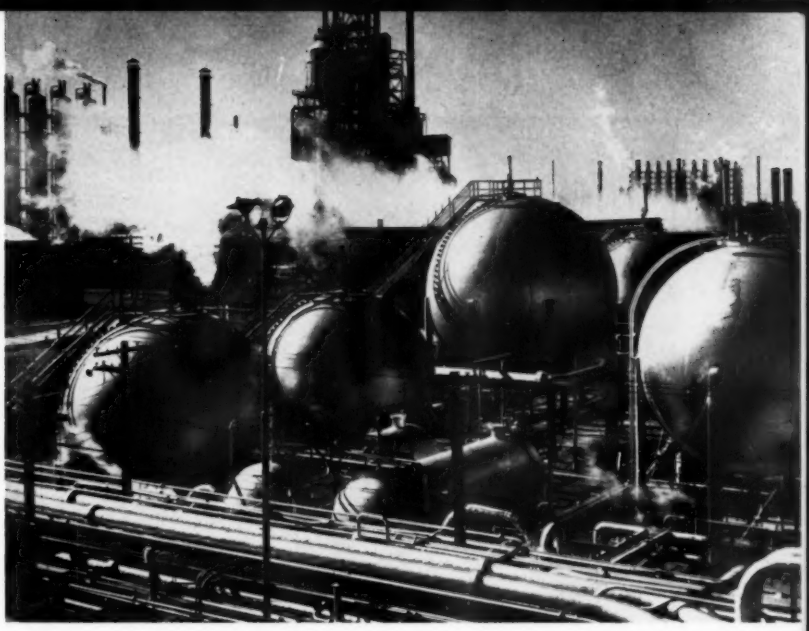

Baytown, Texas, Refinery. Courtesy of Standard Oil Company of New Jersey.

Weather and Oil

ALFRED H. GLENN
A. H. Glenn and Associates

FROM the exploration for new oil prospects in Canada's sub-zero winters to the marketing of petroleum-derived insect sprays on equatorial islands, weather exerts an influence on the safe operation, efficient management, and profitable result of thousands of small and large enterprises that make up the petroleum industry.

Since "Colonel" Drake drilled the first oil well in 1859, oil men have known the importance of being weather conscious. Many sources of weather information from verbal folklore of local residents to complete company weather networks have been employed. As many new oceanographic and hydrologic problems came to the fore, the meteorologist took his place among the large group of engineering specialists employed by the industry; now most major oil companies, as well as many independents and associated contractors, seek the services of a consultant meteorologist or employ a full-time staff of company weathermen.

A comprehensive presentation of the varied meteorological, oceanographic, and hydrologic problems referred to this consultant meteorologist in recent years lies beyond the scope of a short article. Perhaps it would be best to list a number of non-confidential activities in order to give a clear idea as to the scope of the work.

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Study of feasibility of barging cargo offshore compared with cost of dredged channels.

Study of frequency of low tides interrupting navigation.

Exploration:

Planning studies for foreign and domestic exploration campaigns.

48 to 72 hour operational forecasts for scheduling exploration.

Legal:

Compilation of weather data used in litigation.

Determination of effect of wind in changing tide levels in coastal boundary disputes.

Preparation of bibliographies of scientific papers.

(Continued on page 58)

A cross section of the weather to be encountered enroute is explained by an industrial meteorologist to a captain and a stewardess of American Airlines.

The Airline Meteorologist

L. G. FRITZ, *Vice President—Operations, American Airlines, Inc.*

WHEN the Wright Brothers hopped off a North Carolina sand dune into the third dimension of transportation, it became imperative for someone to do something about the weather. Otherwise, the airplane would remain nothing more than a fair weather folly, an interesting novelty of little commercial value.

Airplanes could not operate safely in bad weather, and no one knew exactly when the weather was going to be bad. Meteorology, as it then existed as a science, was best adapted to predicting weather for the farmer. He was content, because he had to be, with an educated guess that conditions would be warmer or colder, sunny or cloudy, with a collateral indication about precipitation.

Such predictions, even as late as 25 years ago, provided slender support for the preparation of flight plans. The early pilot merely went out and looked at the weather, meaning that he flew until he could not see or until what he saw did not look favorable. Then he either landed or returned to base.

Something positive had to be done about the weather if the airplane was to take its place as an economic producer in the field of transportation. In the first place, better forecasts were needed to predict precisely what the weather elements would be at a given point at a given time. Secondly, the aviator, once he knew what the weather was expected to be, had to know how to take advantage of the conditions and bring his plane safely through. The problem was twofold, and the solution came through an ingenious combination of scientific reasoning and of practical mechanical knowledge.

The work of the Norwegian physicist, Vilhelm Bjerknes, and his associates largely solved the problem of providing a usable forecast. The development of the polar front theory and air mass analysis, the basis of modern meteorology, came at the very time that the air transport industry was making a start in America and throughout the world.

The introduction of the new theories produced a revolution in the meteorological picture in this country. In the first place, full-scale departments of meteorology were established in several universities to teach the new methods of analyzing the atmosphere. Then the U. S. Weather Bureau underwent a tremendous expansion in facili-

ties and personnel as hundreds of new surface and upper-air observation stations were established. Vast new communication networks were brought into being by the Civil Aeronautics Authority to disseminate weather reports to the airports scattered throughout the country. The Weather Bureau itself was transferred from the Department of Agriculture to the Department of Commerce in recognition of the new importance of meteorology to all commerce.

Simply knowing what the weather would be, however, would not help much unless means were developed to fly when the weather was unfavorable. Over the past 25 years this problem has been met by the aviation industry with the development of flight instruments and the establishment of airways marked by radio ranges. Today's pilot, with two-way radio linking him to the ground, flies as casually by his instruments in bad weather as the early pilot did by the "seat of his pants" and the horizon. The modern pilot has primary flight instrumentation to maintain a straight and level course regardless of visibility. He has an array of remarkable navigational aids to tell him exactly where he is. His Instrument Landing System will lead him precisely to the landing field and down the glide slope through foul weather to the runway. And from the ground he is monitored by precision Ground Control Approach (GCA) radar as a double check during the final approach.

The majority of airlines now have their own meteorological staffs, and these industrial weathermen are highly respected members of a team, working shoulder to shoulder with the flight dispatchers and pilots in providing safe, reliable air transportation. From time to time there have been suggestions that the various airline weather offices at an airport could be consolidated into one central office and thus provide the same service at less cost. Careful analysis of such suggestions, however, reveals them impractical for the reason that they separate the dispatcher from the weather advisor. The airline weatherman is intimately familiar with the special problems of his particular airline. He is well versed in his company's operating policies. He knows the operating minimums and the local peculiarities of the airports and alternates used by his aircraft, and he knows the capabilities and limitations of the planes themselves. He is on hand at all times to provide instant and expert weather advice to dispatchers, pilots, and company officials on any problems that may arise.

As we look into the future of air transportation, one of the most striking features is the extension of flying at both ends of the speed scale, by the lowly helicopters in the slow range and by the high soaring jets at near sound-barrier speeds. Many new meteorological problems are confronting us, such as more detailed data concerning wind and temperature at high levels, the presence of clear air turbulence, the behavior of the high velocity jet stream flow, and the extension of terminal forecasts for much longer periods in advance.

No great changes in the meteorological position of the airlines are envisioned. The larger companies will probably continue to employ ample meteorological staffs to cope with these new and different problems. A speedier and more widespread exchange of weather information will be required as we progress to non-stop transcontinental flights in this country and to longer range international flights.

Weather maps and charts are received by facsimile transmission at many airline meteorological offices in all parts of the world.

A Department Store Uses Weather

A. THORNTON STEELE, *Associate Professor of Marketing and Merchandising, Western Reserve University*

THE department store is the largest type of retail outlet with the exception of certain chain-type organizations. Furthermore, it concentrates on the selling of shopping goods. A shopping good is a type of merchandise "which the customer in process of selection and purchase characteristically compares on such bases as suitability, quality, price, and style," according to the Committee on Definitions of the American Marketing Association. In order to compare, the customer usually has to be physically present in the store. In the wintertime, weather has its chief effect on sales in keeping customers away from the stores in certain types of weather.

Department stores have long recognized that weather affects their sales. Many department stores regularly write a brief description of the weather for the day immediately following the day's dollar sales figure in their records. The purpose of this is to help in determining the "planned sales" figure for the same day a year later. Thus, if the sales for the day was $80,000, and if the words "cold, windy, heavy snow" were written after that figure, the sales planner would know that $80,000 represented a rather low figure for the day, and he would keep that in mind in attempting to set the planned sales figure for the same day of the following year. Furthermore, the top executives of the firm would have in the notation, "cold, windy, heavy snow," an explanation of the low sales figure of $80,000 instead of the planned figure of $100,000. The weakness of the whole process is that the effect of weather is not measured quantitatively.

In a study undertaken in co-operation with Younkers of Iowa, a department store in Des Moines, Iowa, the writer found that the effect of weather during the Easter season, i.e., seven weeks before Easter, is best measured by the following regression equations (called expectancy equations):

For early Easter seasons:

$$E = 104.73 - 0.0228T - 0.0219P - 0.2635D + 0.0675S$$

For late Easter seasons:

$$E = 109.51 - 0.0361T - 0.0429P - 0.2596D - 0.0189S$$

In the equations, T is the "effective" temperature, combining temperature and wind velocity in such a way as to be proportional to the temperature people *feel*. P is precipitation, D is depth of snow, and S is the percentage of sunshine. E is the sales expectancy index.

The sales expectancy index, which is usually a percentage between 70% and 110%, is then multiplied by the planned sales figure for the day, which has been arrived at by normal statistical procedures. The resulting dollar sales figure is called the sales expectancy. Thus sales expectancy is simply planned sales adjusted for the effect of weather by the sales expectancy index.

An example may help illustrate the use of the expectancy equations in *predicting* the volume of sales. If the carefully computed planned sales for tomorrow (which we will assume is March 3, 1952) is $100,000, the proper expectancy equation produces a sales expectancy index of 106.18% when the forecasted weather (60° F., 4 mph wind, and clear) is put in the appropriate expectancy equation. Thus the forecasted sales expectancy for the day would be $106,180. With this forecast before them, the management of the store would make such plans as are required to handle 6.18% more business than would normally be expected.

After March 3, 1952, has passed, the management looks at actual sales figures to see how well they did. They want to evaluate their past performance. They are particularly interested in how effective their advertising was. Let us assume that the actual sales figure was $104,000, which is 4% higher than the planned sales figure of $100,000. Without having the expectancy equations, management would tend to look with satisfaction on the $104,000 as being above the planned sales figure for the day and therefore conclude the advertising was fairly effective. But, with the aid of the expectancy equations, assuming the weather forecast was perfect, management now knows that the actual sales were below the sales expectancy for the day, and the advertising effort was relatively unsuccessful rather than the reverse.

In like manner it would be possible for actual sales to be considerably below planned sales but to be above the sales expectancy. For example, the weather in Des Moines, Iowa, was as follows: 30° F. at noon, 25 mph wind at noon, overcast all day, 6.4 inches of snow on the ground at the end of the shopping day, and the snow which fell during the day amounted to .6 inch of water. The sales expectancy index was 76.13%. If the planned sales had been $100,000, and the actual sales turned out to be $80,000, it would appear that the advertising had been pretty much of a flop. But the sales expectancy for the day was $76,130! Thus an $80,000 was a huge success, and the advertising manager is to be congratulated, not censured!

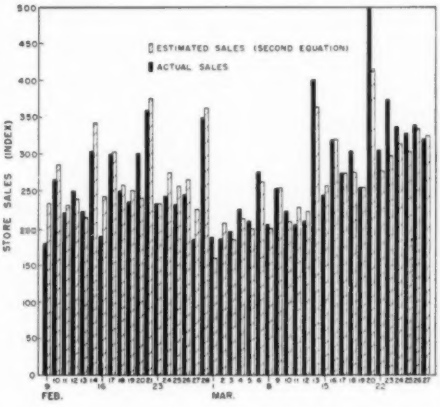
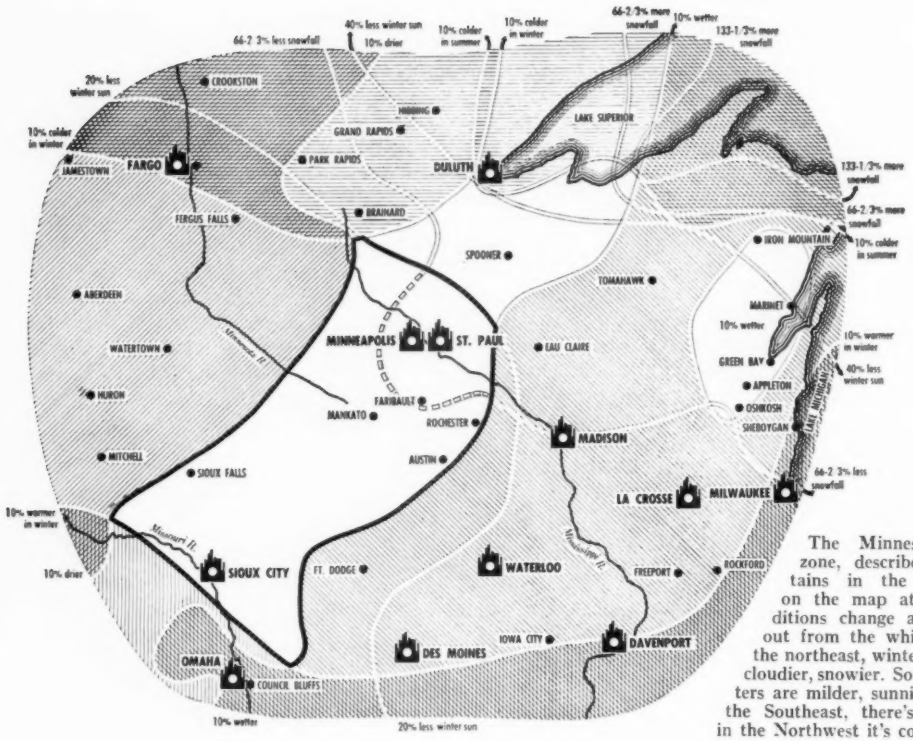


Chart illustrates the relationship between actual sales and sales expectancy, Easter season, 1948, at the Younkers Department Store.

The chart shows the relationship between actual sales and sales expectancy for the Easter season of 1948. During this particular seven-week period in Des Moines there was a wide variation of weather that shows itself very definitely in the chart. During the week of March 1, for example, there was over seven inches of snow on the ground.

A great deal of research has yet to be done. The expectancy equations which apply to Younkers Department Store during the Easter season cannot be applied to any other store nor to any other season.



The Minnesota climate zone, described here, obtains in the white area on the map at left. Conditions change as you move out from the white area. To the northeast, winters are colder, cloudier, snowier. Southwest, winters are milder, sunnier, drier. In the Southeast, there's more rain; in the Northwest it's colder, sunnier.

A Magazine does Somethin

EVERY architect and builder knows that the first purpose of a building is to keep out the weather. And they know that the more satisfactorily buildings keep out the weather the better the buildings will perform their other functions.

Too commonly, however, architects and builders seem unaware of the complexity of climatic patterns and of the variety of ways in which weather affects the structure and the comfort of the people within it. As one prominent architect recently put it, "You can find out all you need to know about the climate by talking to the people in the house next door."

Several years ago, *House Beautiful* magazine became much concerned about indifference of designers to the precise nature of climatic influences. The first thing discovered was that, even where the designer had a desire to build a structure that was well-adjusted to the climate, the information he needed was not at hand. He could, for example, learn something about prevailing winds but almost nothing about the variability of winds during the parts of the day and the months of the year. He could determine, without too much trouble, the movements of the sun, but he could get very little about the amount of heat it would deliver on the surfaces of his building. His knowledge of the extremes of heat and cold and of the duration of extreme conditions (or of any of the in-between conditions), and of the time of day or night that extremes occurred, was very limited where it existed at all.

The ability to design with full consideration to climate, consequently, did not exist. The first question was, why had not the Weather Bureau made the necessary information available? The answer was that no one had asked for it. And to the next question —why had not the building industry asked for the data?—the answer was, the industry did not know of its availability nor how to put it to work.

Into this merry-go-round *House Beautiful* plunged. Employing competent climatologists, it entered into a three-fold research project—(1) to assemble the pertinent data, (2) to develop a method of presenting the data, and (3) to show how the data could be put to use.

After more than a year of experimentation, it was concluded that there was no practical method of illustrating climatic variations by means of maps and diagrams for the country as a whole. Consequently, a switch was made to a method of presentation in which the data for a selected population center were shown and with them the variations that were encountered as one moved along a radius of 200 miles or more from the center.

Following this basic scheme, the data for each of 15 cities were presented on three chart sheets. The first covered thermal analysis, and included temperature variations (wet and dry bulb) for each month of the year by the number of hours at each degree of temperature during the month, with supplemental data on the number of hot and cold days and degree days.

The second chart covered solar and wind analyses and included a unique series of diagrams showing direction and velocity of winds for each part of the day during each of the months. These diagrams vividly revealed the inadequacy of the ordinary data of prevailing wind, since they showed that what prevailed during the night was rarely the same as what occurred in the afternoon and, consequently, that the design of the parts of the house for daytime and nighttime use should be based on quite different factors.

The third chart was concerned with precipitation and humidity analyses. Detailed information on the frequency and intensity of rain and snowfall was provided, and measures of absolute as well as relative humidity were given.[1]

With this material in hand, the job of interpretation was given to biologists, psychologists, and architects; in October 1949, after more than two years of study, the first editorial material was published. In successive issues, houses designed for each of the 15 cities covered by the data were published.

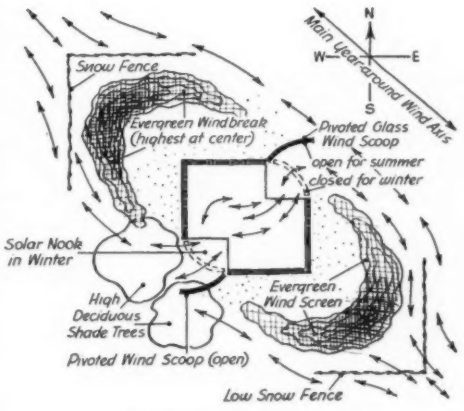
House Beautiful will continue to present articles that in some way deal with the bearing of climate on building design. Extensive though its research has been, it recognizes that only a beginning has been made in awakening the public, as well as designers and builders, to the importance of really taking the climate into account. Even when ignorance is dispelled, inertia remains, and the old ways of doing things are hard to change. Added to this are two other difficulties: (1) the necessary data have been assembled for only a few places, and (2) the job of interpreting the data by the layman is still formidable.

(*Continued on page 62*)

[1] The charts for 15 cities—Columbus, New York, Miami, Phoenix, St. Louis, New Orleans, Chicago, Minneapolis-St. Paul, Washington (D. C.), Boston, Pittsburgh, Portland (Ore.), Charleston (S. C.), Albany, Denver—were published in the *Bulletin* of the American Institute of Architects between the months September 1949 and January 1952.

...nething about the Weather

MILES COLEAN



An idealized climate landscape.

THE AMERICAN METEOROLOGICAL SOCIETY

The objectives of the American Meteorological Society are "the development and dissemination of knowledge of meteorology in all its phases and applications, and the advancement of its professional ideals." The organization of the Society took place in affiliation with the American Association for the Advancement of Science at Saint Louis, Missouri, December 29, 1919, and its incorporation occurred at Washington, D. C., January 21, 1920. The work of the Society is carried on by its publications, by papers and discussions at national meetings, local branch activities, the library, and through the central office of the Executive Secretary.

OFFICERS FOR 1953

President: HORACE R. BYERS, Sc.D., Professor and Chairman, Department of Meteorology, The University of Chicago, Chicago, Ill.

Vice President: BENJAMIN G. HOLZMAN, M.S., Colonel, U.S.A.F., Director of Research and Development, Special Weapons Center, Kirtland Air Force Base, Albuquerque, N. M.

Secretary: CHARLES F. BROOKS, Ph.D., Professor of Meteorology, Harvard University, and Director, Blue Hill Observatory, Milton, Mass.

Treasurer: HENRY DEC. WARD, A.B., Vice-President, Eaton and Howard, Inc., Investment Managers, Boston, Mass.

Executive Secretary: KENNETH C. SPENGLER, A.B., 3 Joy St., Boston 8, Mass.

MEMBERSHIP

Corporation membership is open to commercial enterprises and educational institutions interested in the advancement of meteorology. Dues are $100 per year.

Professional membership is designed for those with special qualifications in experience or training, or who have made contributions to meteorology. Dues are $12 per year.

Regular membership is open to those whose interests or activities in meteorology or climatology would make them desirable members of the Society. Dues are $7 per year.

Student membership is maintained for graduate or undergraduate students who are specializing in meteorology. Dues are $5 per year.

Associate membership offers affiliation with the Society to those whose interests are primarily of an amateur nature. Dues are $3 per year.

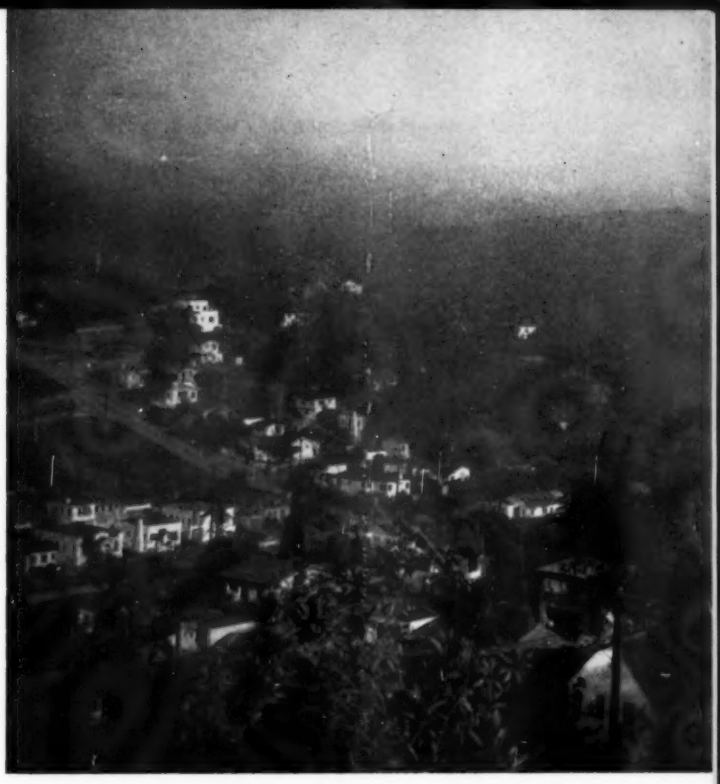
PUBLICATIONS

Bulletin of the American Meteorological Society
Journal of Meteorology
Meteorological Monographs
Weatherwise
Meteorological Abstracts and Bibliography
Compendium of Meteorology

NATIONAL MEETINGS IN 1953

120th New York City, January 26–29.
121st Atlantic City, N. J., March 17–19.
122nd Washington, D. C., April 29–May 4.
123rd Santa Barbara, Cal., June 16–18.
124th Toronto, Canada, September 9–15.
125th Austin, Texas, November 9–12.
126th Boston, Mass., December 29–30.

For full information on all activities of the Society, write to the Executive Secretary, 3 Joy Street, Boston 8, Massachusetts.



Smog—
a Los Angeles
problem.

Meteorology and Preventive Medicine

FREDERICK SARGENT, II, M.D., *Chairman, Committee on Bioclimatology, AMS*

THE worker in a modern business or industrial establishment benefits daily from the systematic inquiries of a corps of specialists in public health and preventive medicine whose chief concern is health protection. The meteorologist has come to play an increasingly significant role in this team. His part is important, for the condition of the atmosphere has many direct and indirect influences on the health and well-being of the worker. With respect to the condition of the air, two major problems face the specialist in preventive medicine: first, the regulation of the condition of indoor air for optimal comfort, efficiency, and health; and secondly, the pollution of the atmosphere by industrial and commercial processes and activities. Although neither problem has been solved, meteorology has made significant contributions toward their eventual solution.

AIR CONDITIONING

Everyone agrees that indoor air should be conditioned, especially in places where large groups congregate to work or relax. As a result of many years of careful engineering research, indoor air can now be filtered or rooms ventilated to remove disagreeable odors, dusts, pollens, toxic gases, and it can be heated or cooled, humidified or dehumidified, and maintained at almost any combination of movement, temperature, and moisture conditions. Our physiological knowledge, however, has not progressed as fast, and the interpretation of published data on the effects of atmospheric changes on comfort, efficiency, and health is still controversial. The standards for the so-called comfort zone are empirical, and there is little clear evidence that one's health is significantly better protected or that one's comfort and efficiency are really improved by working in conditioned indoor air.

The present consensus is that, when conditioning air, probably the chief meteorological factors to be regulated are temperature, moisture, and motion. The combined effects of these three elements on comfort and efficiency have been studied, and a number of useful indices of comfort have accrued. The most widely used is the *effective temperature* scale of the American Society of Heating and Ventilating Engineers. These indices are the basis for many of our modern concepts of

what combinations of temperature, humidity, and air motion constitute ideal indoor environments. The theory that one should live constantly under such empirically ideal conditions has raised a number of basic problems: (1) There are those who contend that protection of man from the stimulating effects of weather changes may have a debilitating effect on his efficiency and even on his health. This doubt deserves serious study. (2) The worker may enjoy an ideal environment while at work, but may suffer on going outside if the environment there presents too great a contrast. This situation is particularly important during periods of summer heat. How great should the contrast be between the indoor air and the outdoor summer weather? Different authorities place the temperature difference at about 10° F. If this statement is true, then the indoor environment should not be kept constant but should be changed, at least in summer, according to daily weather fluctuations. (3) Do temperature, humidity, and air motion constitute all the important meteorological determinants of the ideal environment? Other elements may play an important role in maintaining comfort and maximal efficiency. To mention only a few of the controversial factors, there are the positive and negative ions and the higher polymers of oxygen ("Aran" of Currie). The role of these elements in conditioning air of the indoor environment remains to be investigated.

Atmospheric Pollution

The smoky air of the modern industrial city had long been generally accepted as more of a nuisance than as a serious threat to health. The disaster of Donora, Pa., in October 1948, however, raised the problem that under certain meteorological conditions contaminants might accumulate in the atmosphere of industrial communities to concentrations that would cause not only ill health but possibly also death. A large literature has rapidly accumulated, and there have been claims and counterclaims regarding this health question. Numerous conferences and special research institutes established to study atmospheric pollution have not yet solved the problem. On the other hand, a number of basic facts have emerged and steps have been taken by industry and business to reduce the potential hazards to the health of its employees and of the community as a whole.

Smog is smoke plus fog. It contains fine solid and liquid particles which may be either natural constituents of the atmosphere or derived from man-made processes. Normally, such particulate material is rapidly dispersed by atmospheric turbulence. However, under certain meteorological and topographic conditions these particles may persist. A temperature inversion or a persistent, stable high pressure area, such as frequently occurs in the fall of the year, may act as a lid retarding the removal of these particles. If the moisture content in the atmosphere is sufficient, smog will form by condensation of water on the fine solid particles. Communities located in valleys or basins are more apt to experience smog than those located on open and flat terrain. When the smog is present, the waste products from industrial and business activities tend to accumulate. These waste products are chiefly gases derived from processes of combustion: oxides of nitrogen, sulphur carbon, fluorine and metals, halogen acids, and organic compounds such as aldehydes, peroxides, methane, and alcohol. The compounds may be further modified by the photochemical action of sunlight. They dissolve in the fine aerosol of the smog and their toxicity is thereby increased.

Evidence has accumulated that the presence of smog is correlated with a sharp increase in complaints of irritation of the eyes and skin and in cardiorespiratory symptoms. The latter predominate among the older age groups which are already suffering from diseases of the cardiovascular and pulmonary systems. It has been among these individuals that deaths due to smog have generally occurred. While a variety of irritant and toxic substances have been demonstrated in smog, it is not yet clear whether the ill effects of smog are due to a single agent or to a combination of them.

Two claims have been made which require further investigation. In the first place, data have been reported which show that during short episodes of relatively mild smog, there was a significant increase in the death rate from cardiorespiratory diseases. Secondly, data have been presented which have led to the conclusion that repeated exposure to epi-

(*Continued on page 58*)

Meteorology in a Public Utility

CHARLES PENNYPACKER SMITH,
Chief Gas Dispatcher, Pacific Gas & Electric Company

Pipeline design and construction requires the advice of an industrial meteorologist.

WEATHER is an important factor in the operation of a gas utility since atmospheric temperature, wind, sky cover, and precipitation affect the customer's demands for gas. In the case of utilities which serve natural gas, it may take from a few hours to several days for an increase in field production to become apparent at the load center. It is important, therefore, to know what the weather will be for a period in the future.

Basically there are three possible sources for competent weather forecasts: (1) the U. S. Weather Bureau; (2) various private weather forecasting services; (3) a weather forecasting unit within the utility. Which of these sources will be most economical and satisfactory must be determined by each utility. The Pacific Gas and Electric Company maintains its own forecasting unit and has found it well worth the cost.

The primary mission of the company meteorologist is to provide the weather information required by the personnel who direct the production and distribution of the company's gas supply. It is necessary to anticipate changes in customer demands for gas from 24 to 36 hours in advance because of the time required to transport the gas from the field to the load centers. Day-to-day changes in demand are largely determined by the weather, particularly in winter.

Temperature is the most important meteorological element involved in estimating gas demand. Roughly speaking, a one degree fall in the mean temperature, when the mean is below 65° F., will increase the daily customer demand by 28 million cubic feet of gas. If it were possible to forecast consistently the exact mean temperature, the gas dispatcher could control the production and inventory of gas with a high degree of accuracy. Since it is not possible at the present state of weather forecasting to supply such an optimum forecast, it is necessary to consider what effect a particular weather forecast will have with the conditions existing in the gas system.

Our meteorologist is thoroughly familiar with the gas system and its operating procedure. He is located in the same room and works closely with the system gas control dispatchers who direct the gas supply for all of northern and central California. He must keep in close touch with the hour-by-hour problems involved in planning and controlling the flow from 48 gas fields to over 1,100,000 consumers and, further, to weigh each forecast in the light of company security. It would obviously be impractical for any agency not directly responsible to the company to maintain this close relationship.

Although the primary function of the me-

(Continued on page 50)

FOR ACCURATE,
INSTANTANEOUS
MEASUREMENT OF
AIR VELOCITY . . .
A HASTINGS AIR METER

Reads directly in cubic feet of air per minute. Indication is accurate, regardless of temperature, distance from meter to probe, or line voltage variations.

Probe is self purging. Oil, soot or other airborne contamination will not affect accuracy for more than a few minutes.

These meters are extremely sensitive. Low air velocities (under 50 fpm) are indicated on an expanded logarithmic-type scale. Recalibration between ranges is unnecessary. Operates on 105-120V AC supply. Directional or non-directional probes available.

MODEL B. For measurements of greatest accuracy. Two velocity ranges: 0 to 400 and 400 to 6,000 fpm. Continuous calibration check. Parallel free indicator. Accuracy, 2% of scale indication. $475.00, with standard directional probe.

MODEL H. Compact unit for field or laboratory. Velocity range: 10 to 750 and 750 to 5,500 fpm. $190.00, with standard probe.

MODEL P. Similar to the Model H, but with self-contained power supply. $190.00, with standard probe.

MODEL G. Highly compact unit. Weighs only 26 ounces. Velocity range: 0 to 400 and 400 to 6,000. $50.00 (sensitive), with probe.

Write for descriptive literature.

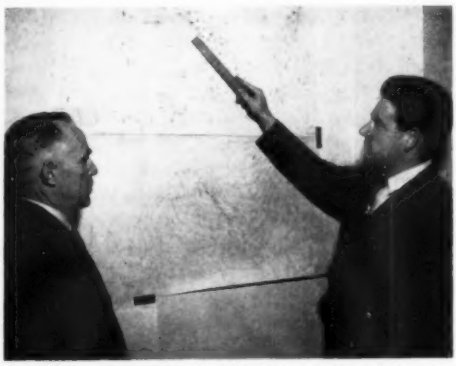
HASTINGS INSTRUMENT COMPANY, INC.
HAMPTON 5, VIRGINIA

PUBLIC UTILITY

teorologist is to prepare forecasts for the system gas control dispatching office, he also provides forecasts for other company activities. There are always construction projects under way that require various types of forecasts. Maintenance work on both the gas and electric facilities are greatly affected by the weather, and the supervisory personnel must be alerted to extreme or unusual weather conditions. Forecasts are prepared for mountain regions to assist the personnel responsible for controlling the hydro-electric system.

Climatic influences are extremely important in the utility industry. Detailed climate data must be considered in the planning, design, and construction of both hydro- and thermo-electric generating plants, electric distribution and transmission lines, gas distribution and transmission mains, compressor plants, and various other installations. The meteorologist's experience is available for consultation with the engineering departments responsible for planning, design, and construction.

Our meteorological unit consists of one full-time meteorologist and two relief meteorologists. During the winter months forecasts are prepared seven days each week. A relief meteorologist substitutes two days a week during this period, on holidays, and in the event of sickness. The relief meteorologist also functions as assistant gas dispatcher, a position for which meteorology provides an excellent background. Needless to say, it is necessary to utilize the meteorologist during the slack summer months. This time is usually devoted to research and load studies.



The meteorologist briefs the gas dispatcher.

Climatology Applied by the Air Force

WILLIAM O. SENTER, *Major General, U. S. Air Force*

THE Air Weather Service is engaged in a variety of activities above and beyond the routine observing, forecasting, and briefing service provided at each Air Force base. For example, regular and special aerial weather reconnaissance is conducted over the Atlantic and the Caribbean, in addition to the Polar and Pacific regions, to cover the remote ocean and land areas where ground weather stations cannot feasibly be located; meteorological assistance of a specialized nature is supplied military agencies engaged in rocket and guided missile operations, chemical warfare, nuclear physics, and ballistics projects; support is provided for special maneuvers; and climatological studies are undertaken for research and development, military planning, and daily operations.

To accomplish the foregoing, three basic functions are involved: to observe the weather; to forecast the weather; and to supply a climatological service. The functions of observing the weather and forecasting the weather are obvious ones, but what is this "climatology" which apparently has equal status with the more commonly accepted functions of a weather service? A few examples will serve as illustrations.

The invasion of Poland, initiating World War II, was launched in September because German meteorologists had determined from historical weather information that Panzer tanks could expect the driest soil conditions and their Stuka dive bombers would be hampered least by cloudiness in this than in any other month. Excellent weather conditions prevailed and the operation was completed within three weeks. The climatologists could claim a valuable assist in this invasion.

Climatology played an important part in Operation "Vittles," the Berlin Airlift. By knowing well in advance the approximate frequency of VFR (Visual Flight Regulations), IFR (Instrument Flight Regulations), GCA (Ground Control Approach), and closed weather at each of the terminals, an accurate calculation of overall gas load and payload was made possible. The frequencies predicted on the basis of climatology approximated quite closely those actually experienced.

More recently the Korean invasion was begun in June because of climatic conditions. The North Korean commanders were undoubtedly aware that any opposition would be relying heavily upon air support. By scheduling the attack to begin early in the monsoon season, the chances of successful air support by the opposition were at a minimum.

The above are excellent examples of the proper use of climatology. There are many examples of the misuse or lack of use of climatology, sometimes with disastrous results. Thus, the Gallipoli operation in World War I was planned without any consideration being given to the desert-like summers in Turkey. As a result, provisions for water supply were dangerously inadequate.

Climatology may be defined as the science and branch of meteorology concerned with historical weather information. For many years meteorologists and non-meteorologists alike have practiced the classical, or descriptive climatology wherein the climatologist presents a general account of the conditions in an area accompanied by voluminous tables of climatic data. While such general studies are not completely useless, it is evident that they are not very helpful to the planner who is seeking specific answers to specific problems, since it falls to the planner to separate pertinent data from reams of irrelevant data and to interpret them accurately and completely in terms of his operational requirements.

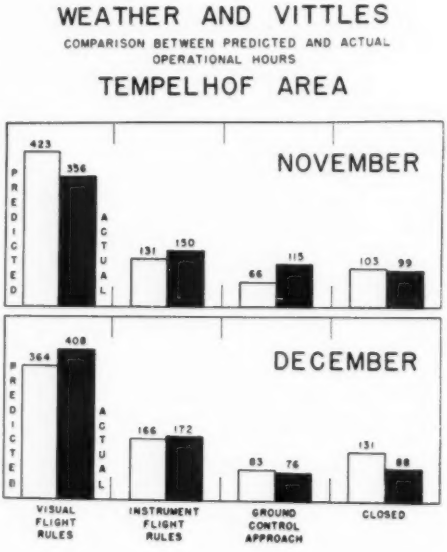
The Directorate of Climatology, Headquarters Air Weather Service, has made great strides away from descriptive climatology toward "applied climatology," which may be defined as "the analysis of individual weather conditions in the light of useful application for operational purposes with the end in view of modifying an operation to advantage." The applied climatological study includes the following two essential features: First,

the analysis and formulation of the problem. This can best be accomplished by consultation between the meteorologist and the planner. It requires that decisions be made regarding the weather criteria to be used. Secondly, the answer to the problem is phrased in operational terminology so that the planner can use it directly without further interpretation. In planning a tactical operation the planner wants to know about the effects of weather on his tanks, planes, or troops. He has specific problems for which the climatologist can provide specific answers. He does not want to dig through volumes of writing and data describing the climate of the area. Instead, through consultation, the planner and the climatologist will formulate the problem. For example, the planner may decide that his aircraft must have ceilings of 500 feet and visibility of five miles for the operation. What are the expectancies of such minimums for a given period? The climatologist, from his analysis of historical weather data for the region, will then express his answer in operational terms that the planner can use directly. Proper use of applied climatology during the planning phase of an operation is essential and can often determine its success or failure.

The climatic analysts of the Directorate of Climatology are technically qualified to express the operational problem in terms of a weather problem. They are capable of analyzing the data and information and can present the results in proper form to the using agency. Many of the climatic analysts are not only trained meteorologists, but they also have a secondary specialty that enables them to interpret the varied problems received by the Air Weather Service.

If there is one thing that characterizes climatology above all else, it is the tremendous quantity of basic data that are required to exercise the field adequately. The Data Control Division of the Directorate of Climatology acts as the data supporting agency responsible for the acquisition, evaluation, processing, and filing of required meteorological data. It prepares climatological tabulations and summaries on a routine or special project basis, as required by the field or headquarters climatologists and utilizes a library of approximately 200 million punched cards maintained jointly by the Air Weather Service, U. S. Weather Bureau, and Navy Aerological Section, from which tabulations and summaries can quickly be secured through the use of IBM machines. Further, it is responsible for annotating and maintaining information files on the location of climatic data required by the Air Weather Service, programming the acquisition and processing of data on worldwide basis.

The Post Weather Analysis Division of the Directorate fulfills the final climatological function of filling the gap between current analysis forecasting and climatology as it is usually defined. This unit is primarily concerned with weather data of the recent past and the analysis of the cumulative effects of weather on operations and activities of contemporary military interest.

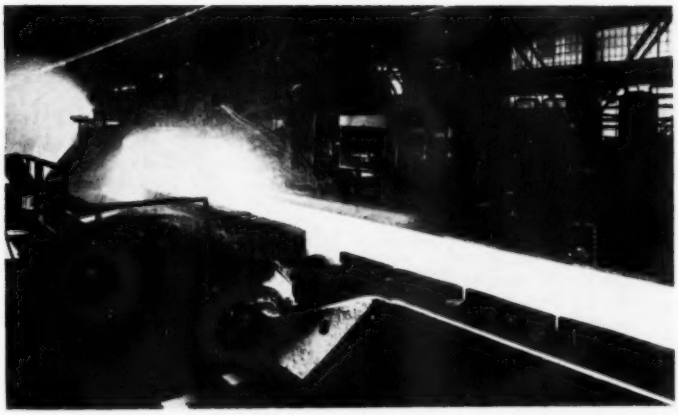


PROFESSIONAL DIRECTORY

A directory of all professionally qualified members of the American Meteorological Society who are engaged in private industrial meteorological work is maintained at the office of the Executive Secretary, 3 Joy Street, Boston 8, Mass. A copy may be obtained upon request.

Steel

MICHAEL HANSELMAN,
Engineering Department,
Jones & Loughlin
Steel Corporation



Steel production. Courtesy of Union Carbide & Carbon Corp.

FROM the mining of raw materials to the shipment of finished steel products, weather exerts a definite, though generally a taken-for-granted, influence in the production of steel. The severity of freeze-ups in the ore fields and on the lakes determines the length of the ore shipping season. (See WEATHERWISE, Feb. 1953, p. 7.) Harbor and docking operations and facilities on the lakes and rivers are handicapped by the occurrence of strong winds, icing conditions, fog, and high water. Snow and rain hamper the handling of rail shipments of coal, ore, limestone, and other raw materials needed in the manufacturing process.

At the furnaces, excessive moisture in the solid raw materials reduces production, while varying amounts of water vapor in the air alter the heating value of the gases. The high humidity of summer days may cause rapid rusting of unprotected steel in finished form. Weather at the shipping terminals often influences the manner in which steel is packaged and prepared at loading time and also determines the flow and availability of transportation facilities. Bad weather hampers yard movements and general outside work around the mills.

It is not difficult to acknowledge the useful service that a sound weather advisory can perform in the industry. Such a service can minimize the slow-down effects of bad weather by giving timely notice of its onslaught. These warnings allow for the efficient organization of operating and maintenance schedules and permit adequate preparation for potential mechanical and equipment failures. It is the job of the industrial meteorologist to keep his company posted on the weather outlook and to interpret it in terms that are useful to his employers.

Specifically, in recent years, the iron and steel industry has called upon the meteorologist to help resolve the air pollution picture. At the start of the year 1950, the Jones & Laughlin Steel Corporation hired a trained weather observer to assist in the study of the pollution problem. It was recognized from the start that the mere sampling of air for waste products in the adjacent community had little meaning unless it was known how, when, and to what extent the pollution was carried about in the atmosphere. To this end, during the past three years, a thorough investigation into the micrometeorology of the Pittsburgh valley and hill area has been integrated with the mobile-type investigation of air sampling in the same area. Today, it is possible to predict with reasonable certainty what may be expected in the way of air pollution and atmospheric behavior under typical conditions.

In the Jones & Laughlin Steel Corporation the meteorological service is available to management and supervision of the various departments. They may call upon the meteorologist to relay, interpret, or analyze whatever weather information or climatological data will be useful in the company's operations.

Weatherwatch

A Mild Winter Across the Nation

DAVID M. LUDLUM, *Editor*

THE three winter months of 1952–53 comprise one of the warmest winters in recent history when considered on a national scale. A search of the records takes one back to the season of 1920–21 to find a similar period when the greater part of the country from the Atlantic to the Pacific enjoyed above normal temperatures from December through February. There have been periods since then, of course, when one part of the country or another has had a very warm winter, such as that of 1931–32 in the East or that of 1933–34 in the West, but above normal readings for the country as a whole over a span of three months are seldom experienced.

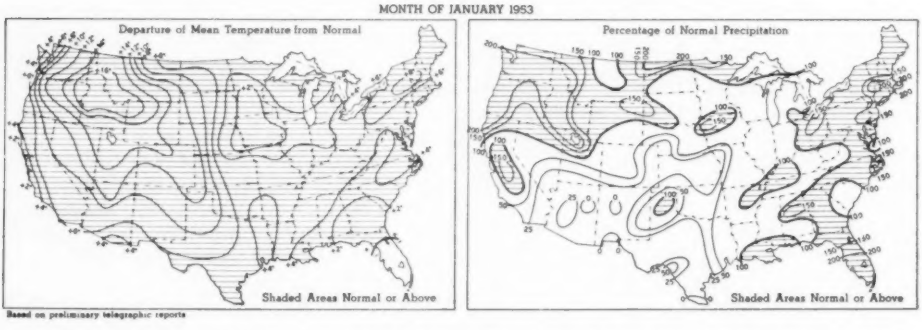
THE CIRCULATION—The pressure pattern around the globe in the northern hemisphere showed great areal contrasts in the middle and northern latitudes, a fact that readily explains the remarkable differences between the winter weather experienced in Europe and in North America. It was a continental winter in western and central Europe with prolonged periods of cold and snow, a season that was highlighted by the great North Sea storm of January 31st that caused the disastrous breaks in the dikes of England and the Low Countries, resulting in the worst flood disaster in over 500 years.

The dominant feature in the hemisphere circulation pattern was a large ridge of high pressure over Siberia that poured great quantities of cold air outward in all directions. Over Europe these eastern air masses created continued stormy conditions as they entered a European trough and mixed with the mild currents from the central Atlantic. A great temperature contrast developed over Europe from north to south to encourage storm development.

Over eastern Asia and Korea, these same air masses caused a cold, but relatively dry, winter as they poured out of the great Siberian land mass as northwest winds. Once out over the Pacific, these Siberian air currents came under the influence of a very well-developed Aleutian low that stretched out from west to east along the lines of latitude. A tight pressure gradient developed between the deeper than normal Aleutian low and the stronger than normal Pacific high to force a broad ban of westerlies across the vast Pacific Ocean at great speed.

Upon approaching the North American land mass, the Pacific flow was given a short nudge northward as, circled around the shoulder of a ridge over the Pacific States and moved inland as a west-southwesterly flow to bring mild and moist conditions to the coastal areas. The shoulder of the Pacific Coast ridge was not of great enough extent to force the westerlies far to the north with the result that they rushed eastward across the Plateau and the Rockies to bring Pacific influences to the weather of all parts of the country. So fast was the speed of these westerlies and so great their persistence, they excluded all influences from the Arctic and Canada, except for very brief periods, and brought a remarkably mild and open winter to all central and northern sections.

The mean upper-air maps of January and February show a trough of low pressure extending from the large Aleutian low northeastward to another persistent low over northern Hudson Bay and Baffin Land. To the south of this axis, it was very warm; to the north, it was a normally cold


MONTH OF JANUARY 1953
Departure of Mean Temperature from Normal
Shaded Areas Normal or Above
Based on preliminary telegraphic reports
Percentage of Normal Precipitation
Shaded Areas Normal or Above

Departure of mean temperature from normal in degrees F., January 1953. USWB chart.

Percentage of normal precipitation, January 1953. USWB chart.

winter along the coasts of the Canadian Arctic and in Alaska.

Downstream from the ridge in the Pacific States, as in December, lay a weak trough from the central Great Lakes south-southwestward to Texas. Most of the real winter weather was experienced in this trough, which was the principal storm track of the month. Blizzard conditions developed twice in the western section of the trough. In the East ridge conditions again dominated. Modified Pacific air usually followed cold fronts and Gulf air preceded them, to supply the ingredients of a very mild winter.

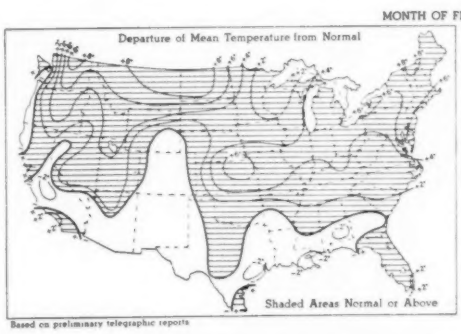
TEMPERATURE—The only section that could complain of fairly persistent cold was the Florida peninsula where December had two freezes and averaged about two degrees below normal, January was just about normal, and February came back with averages from normal to about two degrees above. It was also below normal in December and February along the Gulf Coast, and in parts of Texas, but a very warm January masked out the minus departures to give the winter as a whole an almost normal figure.

The warmest period nationwise extended from the last week of December, when an outbreak of polar air sent the mercury tumbling in all sections east of the Rockies for a short period, to about the 10th of February. The plus departures were particularly marked in the interior of the Northwest where January was a record breaker. In central Idaho and southwestern Montana some weeks averaged 20 degrees above normal and the month as a whole was 16 degrees above the usual figure—the warmest mid-winter month ever experienced there. Helena and Missoula, Montana, and Salt Lake City, Utah, as examples, all exceeded their previous warmest Januarys, the latter by the remarkable figure of three degrees, and the mercury once hit 60° there for a January record. The coldest weather of the winter came early in the West with low readings in both November and December; the −44° registered at Bondurant, Wyoming, on December 26th appears to have been the lowest for the entire winter.

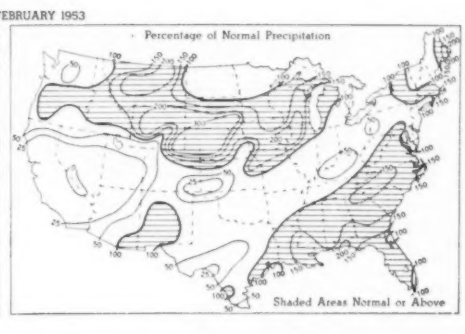
January was also very warm in the Northeast though on a lesser scale than in the West. After a warm December, the mercury remained at high levels for the next 45 days to bring dismay to snow-lovers, whether skiers or hydrologists. The further north one went, the greater was the plus departure from normal, with northern New York and New England turning in a plus six degrees for the three winter months. On the Great Lakes it was an almost ice-free winter, and brought the earliest opening of Buffalo harbor on record. The skipper who arrived there from Detroit on March 2nd reported that there was hardly enough ice on Lake Erie to mix a good cocktail! Preliminary reports indicate that the lowest temperature for the winter in the East was a mark of −23° registered at Lemington, Vermont, on December 31st, a torrid figure compared to the low of −46° reported in Maine the previous winter.

In the Middle West and upper Mississippi Valley it was also an open winter, though trough conditions with northwest flow kept the plus departures there to a minimum for most of the winter. Cold air penetrations were limited to the northern border. One outbreak dropped the mercury to −41° at Orr, Minnesota, but the westerlies quickly sealed off this breach in their defenses as well as all others, so cold periods were of short duration and limited extent. The zero line dipped past Chicago only once, reaching into northern Ohio and Indiana and to northern Missouri in mid-February, but for the rest of the time it was confined to central Wisconsin and Minnesota.

PRECIPITATION—Rainfall during the past winter clearly shows the influence of the prevailing circulation pattern. It was very wet in the central and northern Pacific States as a constant flow of onshore winds brought moist air masses against the coastal mountains. Some very heavy rains fell in mid-January in northern California and southern Oregon, an area that had heavy snow and rain in early December. For the period of January 17–19th, Cape Blanco, Oregon, had 14.17 inches, of which 7.66 inches fell in a 24-hour period on the 17–18th. Some moisture penetrated eastward with the swift-flowing westerlies across the northern Plateau and the Rockies and out onto the Plains


MONTH OF FEBRUARY 1953
Departure of Mean Temperature from Normal
Shaded Areas Normal or Above
Based on preliminary telegraphic reports

Departure of mean temperature from normal in degrees F., February 1953. USWB chart.



Percentage of normal precipitation, February 1953. USWB chart.

where averages were above normal. Two blizzard conditions added to the totals on the Plains when Gulf air overran the mixture of Pacific and polar air. In the South, however, from California to east Texas there was a dearth of rainfall, and soil conditions were becoming dangerously dry northward into Colorado and Kansas.

The Gulf and Atlantic states were in the southwesterly flow on the eastern side of the central trough that persisted throughout January and February, and thus received copious moisture from the Gulf and the Atlantic to give above normal amounts in all areas adjacent to the coast.

Snowfall in 1952–53, in direct contrast to the previous winter, was much below normal in most areas. East of the Rockies the greatest accumulations were reported in the Lake Superior area where Houghton, Michigan, reported a cover of 52 inches on March 1st. In New England maximum depths were only 20 inches, or one-third of the excessive cover reported the previous year. In the western mountains the pack was also below normal; the greatest depth was at Crater Lake, Oregon, with 116 inches on the ground, about one-half of last year's mark. Several blizzards swept the central Plains, but they were soon followed by westerly winds and mild conditions so suffering and losses were not great.

A severe ice storm gripped the northern suburbs of New York City on January 9–10th and extended in an arc from Connecticut to Maryland, cutting off electricity in over 250,000 homes. Otherwise, there were no severe storms in the industrial cities of the East.

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NEW SCIENCE

The odd thing about industrial meteorology is that the industries are slow in seeing its worth. The industrial leaders are not looking for bright young meteorologists to solve their weather problems. In many cases they hardly know that they have any problems linked with weather, or at least that it is possible to solve some difficulties with weather advice. Industrial meteorology has to be *sold*. Happily, most of those who have bought it are pleased with the results and ask for more. Cases of failure have been mostly of two kinds: (1) where the user has failed to take the meteorologist into his confidence to acquaint him with the business and permitted an untrained person to use stereotyped information; and (2) where the meteorologist has promised too much.

The failures stemming from the customer's side can be overcome if all hands know that this is a job *within* the operations of the company in which the meteorologist is to play a part. The meteorologist, for his part, must not promise more than he can give. It is true that commerce and industry would benefit most from exact day-by-day weather forecasts a month or more ahead. The need for these is very great and one could afford to pay well for them. The temptation for the meteorologist to issue these, perhaps even with tongue in cheek, also is very great. Such accurate long-range forecasts simply cannot be made now or in the foreseeable future. This is one of the many reasons why the American Meteorological Society's Code of Ethics came into being. It is our hope that more and more businesses will learn that they can check up on the services offered by anyone in the field of meteorology by calling our headquarters in Boston.

What is the future of this new science? Industrial meteorology is becoming an accepted service more and more each year. If we are to project its present rate of growth into the future, we come to a time, perhaps 10 years from now, when every sizable business undertaking will make use of private industrial meteorology, some of them in fields not now dreamed of. With this growth the meteorologist will become more keenly aware of the important part he can play in commerce and industry and will make himself more valuable than ever.

RECORDS CENTER

Machines sort weather punched cards to make possible analyses of industrial problems.

development of industrial climatology is a realization, on the part of all concerned, of some of the problems facing this new and important field. On the part of industry, there is a need for the staff specialists or consultants to define the problems more specifically and clearly than has been done in the past and to determine more accurately the relationship of the various weather factors to the problems. On the part of the Weather Bureau, there will be an increased effort to put its data, particularly past data, in a more flexible form. It should be understood that the analysis of thousands, and often millions, of weather observations in a variety of ways is a laborious task requiring flexible tools for analysis and an adequate staff to perform the task. The modern machine card affords a flexible and economical approach to such problems, but large volumes of data in manuscript form still await reduction to card form, and until that situation can be rectified, a large resource of climatic data will remain a "frozen asset."

Hourly observations at first-class weather stations are now put on punched cards daily.

OIL

(*Continued from page 39*)

Pipeline and Refinery:

48 to 72 hour operational forecasting for scheduling construction.

Hurricane shutdown problems.

Operational forecasting and design problems at exposed tanker terminals.

Design studies for offshore pipelines.

Precipitation and temperature forecasting for inland pipeline construction, maintenance, and operation.

Air pollution problems.

Soil temperature studies affecting construction and design of pipelines.

Aviation:

Ceiling and visibility forecasting.

Wave forecasting for amphibious aircraft.

Marketing:

Temperature data for natural gas marketing.

Temperature studies for estimating fuel oil consumption.

Research:

Oceanographic data employed in recent sedimentation studies.

Study of anomalous radar propagation for horizontal control in geophysical surveying.

Oceanographic data used in pipeline fouling and corrosion problems.

48 to 72 hour operational forecasting for scheduling research field work.

Tanker Operation:

Selection of ocean routes for most favorable current and wind conditions.

This list is not complete—new problems appear almost daily. As with other industrial engineering developments originally of controversial value, the employment of the consulting and company meteorologist in the petroleum industry, once looked upon with skepticism, has taken its place with other accepted technical services. The future looks to an improvement in present services and a widening horizon for many new applications.

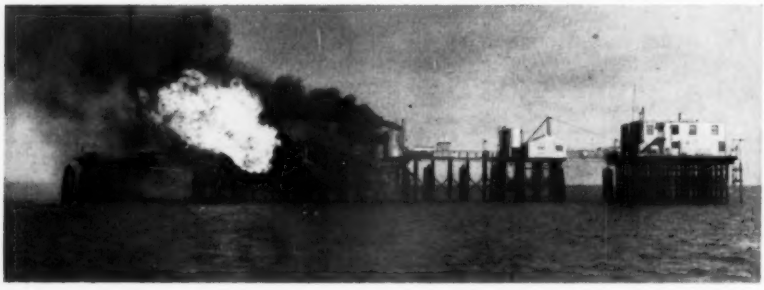
PREVENTIVE MEDICINE

(*Continued from page 48*)

sodes of smog might produce chronic disease, especially of the cardiorespiratory systems. Industrial medical experience does not substantiate the latter claim.

Two principal steps have been taken in industrial programs of abatement of atmospheric pollution. (1) Mechanical devices have been installed in stacks to purify the wastes before they are discharged into the atmosphere. Such devices have considerably reduced soot and fly ash, but removal of the gaseous material presents a difficult and expensive problem which has not yet been satisfactorily solved. In the chemical industry this latter problem is especially significant. (2) Industry has begun to use the advice of the meteorologist. When atmospheric conditions appropriate for the formation of persistent smog are imminent, plant operation is temporarily curtailed. Also when new plant construction is under consideration, a site is selected wherein conditions favorable for the formation of smog are infrequent.

Smog then is a potential hazard to comfort and health. It is not only an industrial problem but also a community problem. Certainly smog is more than a nuisance. It is one of the many atmospheric stresses to which the human must adjust and adapt. Since smog is essentially man-made and hence subject to control, its abatement would seem to be a good investment in preventive medicine.



The meteorologist in the oil industry is often called on for emergency forecasts.

(*Continued from page 37*)

fall on our own fields where we want it even if we succeeded in producing it.

The Laboratory of Climatology has helped Seabrook Farms by developing planting schedules for the various crops to give uniform harvest and to make it possible to harvest at any desired stage of maturity. By smoothing the flow of produce into the processing plant, these planting schedules have greatly increased the efficiency of use of labor and equipment both in the factory and in the fields. This has been a very useful by-product of the work on plant phenology which the laboratory has undertaken.

Agricultural climatology is no new science; its broad outlines were marked out more than two centuries ago. But it was not realized that special climatological observations made in close proximity to the growing plant were necessary to determine the relations between climates and crops. The Seabrook laboratory has pioneered the new field of agricultural microclimatology, and with the precise observations that we obtain in the layer near the ground, we expect gradually to come to understand the climatic factors that affect our farming operations.

So far as I know, Seabrook Farms is the only commercial farming organization in the country that is actually studying ways of adjusting its operations to weather and climate. I have been satisfied with the progress of our study and hope that other organizations will find it desirable to follow our lead.

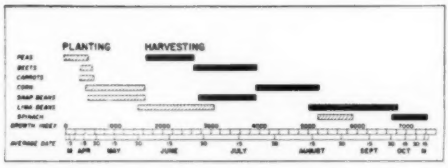


Chart shows relationship between planting and harvesting times of crops as developed by the Laboratory of Climatology.

TALK ABOUT THE WEATHER!

In one 24-hour period 374,000 telephone calls for the weather forecast were received in the New York City area alone!

WALLACE E. HOWELL, Sc.D.
CHARLES S. WETTERER

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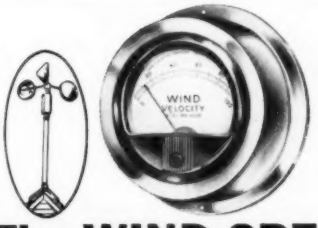

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Micrometeorology. O. G. Sutton. McGraw-Hill Book Company, 1953. 333 pages, $8.50.

In recent years, the behavior of the atmosphere near the ground has received considerable attention from meteorologists the world over. *Micrometeorology* deals with this special branch of meteorology relating to the air layers near the ground and is the first complete book to be written in English which gives a systematic account of the mathematical physics of the lower atmosphere. Although the treatment is essentially theoretical and written primarily for the graduate student in meteorology, it includes specialized techniques for solving problems which might arise in agricultural meteorology, hydrology, air pollution and the like.

The development of micrometeorology as an exact science demands not only the examination and interpretation of highly accurate observations in the lower atmosphere but also a study of the physical processes which give rise to microclimates. This implies a detailed knowledge of the motion of air near a solid or liquid boundary of variable shape and changing temperature. The earlier chapters of the book discuss some of these basic studies: constitution and physical properties of the atmosphere, general aspects of motion near the surface of the earth, origin of turbulence, mathematical theory of the conduction of heat, and radiation. Some of the fundamental concepts developed earlier are applied to more practical problems in the final chapters of the book, entitled "The Temperature Field in the Lowest Layers of the Atmosphere," "Problems of Wind Structure near the Surface," and "Diffusion and Evaporation." It is in this last chapter that much of Professor Sutton's original work on atmospheric diffusion, for which he is so well known, is recorded. A portion of this chapter sets forth a fairly thorough review of the theoretical aspects of evaporation and contains the following statement which was of interest to the reviewer: ". . . that the diffusion of vapor from a small surface placed on the ground is primarily determined by the boundary layer formed by the test surface, and not by the properties of the earth's boundary layer, so that extrapolation to large areas is unsound." This, of course, implies that the evaporation pan (evaporimeter) is a meteorological instrument of doubtful value.

Micrometeorology is a very clearly written and well-prepared book. Although it is mainly theoretical, each chapter is introduced with a concise survey of the material to be presented and then proceeds to the detailed and precise exposition. An excellent bibliography is included at the end of each chapter.

Fred D. White
U. S. Weather Bureau

"The chapter on photometry is the best I have seen in any book. . . . The book is clearly without parallel in English or any other language. The bibliography alone is justification for the book, and I feel sure that it will be widely and favorably received throughout the world."—A professor of physics at a leading American Institute of Technology.

VISION THROUGH THE ATMOSPHERE

By W. E. Knowles Middleton

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Mr. Middleton is a member of the staff of the National Research Council of Canada.

University of Toronto Press

WEATHER BUREAU

(*Continued from page 32*)

650,000 local weather forecasts for general public
600,000 aviation weather forecasts

The accompanying chart shows the location of radiosonde stations in North America and in the Atlantic and Pacific Oceans for sounding the conditions of pressure, temperature, humidity, and wind from the surface up to altitudes of about 50,000 feet. Obviously these soundings are of service to air commerce, but it is not so evident that they provide benefits also for agriculture, business, and industry until it is remembered that the data from these soundings are indispensable to the forecasting of amounts of rainfall and to warnings of the development and approach of cold waves, hurricanes and other storms.

Although the several meteorological service functions are so inter-related that clear separation of costs among the various branches is impossible, the approximate division for different purposes is indicated below:

BASIC:	
Climatological data	12%
Synoptic data (surface & aloft)	33%
Research	2%
Administration	5%
SERVICES:	
Agriculture	2%
Aviation	20%
Fire Weather (forests)	1%
General Public including business and industry (River and flood as well as weather reports and forecasts)	22%
Marine shipping	3%

Perhaps of most interest to business and industry in reviewing the present services of applied meteorology are the indications of the latent opportunities in industrial meteorology still awaiting development. With each advance in the science of weather forecasting and each increase in the time range and specificity of forecasts (with reliable accuracy) there are incalculably greater practical applications. Most of these specific and individual business uses of weather service are beyond the scope of the Weather Bureau and are the responsibility of private enterprise and the industrial meteorologist.

MAGAZINE

(*Continued from page 45*)

These difficulties can be fully solved only by work beyond what can be undertaken by a single publication. It may be hoped that the impetus given by *House Beautiful* will ultimately result in the preparation of a climate atlas by the Weather Bureau. It may also be hoped that professional meteorologists and climatologists will concern themselves with construction problems more than they have in the past. A new field of consulting service is waiting to be plowed. Individual building owners, architects, builders, mechanical engineers, utility companies, city governments are all possible clients.

A vital pioneering job has been done. The potential usefulness of climate data has been demonstrated. A vast research and educational job, however, must be carried on before the possibilities of climate control are thoroughly realized. *House Beautiful* plans to do all it can to increase knowledge and maintain interest, and it wants to encourage others to get into the act. Every climatologist should be a missionary for climatology.

NATIONAL ASSOCIATION OF INDUSTRIAL METEOROLOGISTS

This organization is composed of individuals and companies that are engaged in the practice of meteorological engineering on a consultant basis. Its objectives are to inform the public as to the availability and capabilities of private meteorologists and to maintain high ethical standards in the profession. Further information may be secured from the secretary: John R. Murray, Murray & Trettel, Main Street at Crawford Avenue, Skokie, Illinois.

COMPENDIUM OF METEOROLOGY

The Compendium is a monumental survey of the field of meteorology from pole to equator, from microseisms to ionosphere, that both summarizes and appraises our present knowledge of meteorology and points the way toward future development. Each of the 108 articles contains a separate bibliography. Edited by Dr. Thomas F. Malone and published by the AMS. 1315 pages plus index in one volume. $12.00 per copy. Order from the AMS, 3 Joy Street, Boston 8, Mass.

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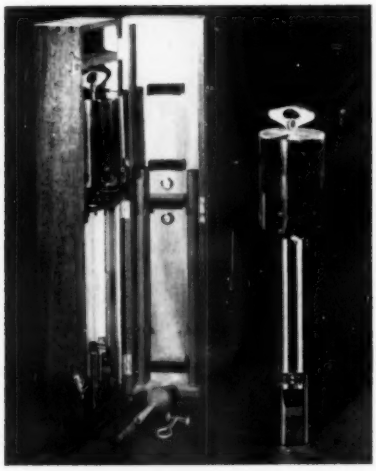

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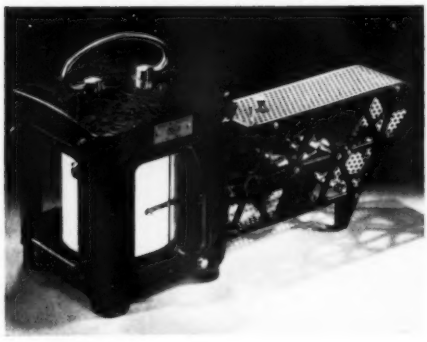

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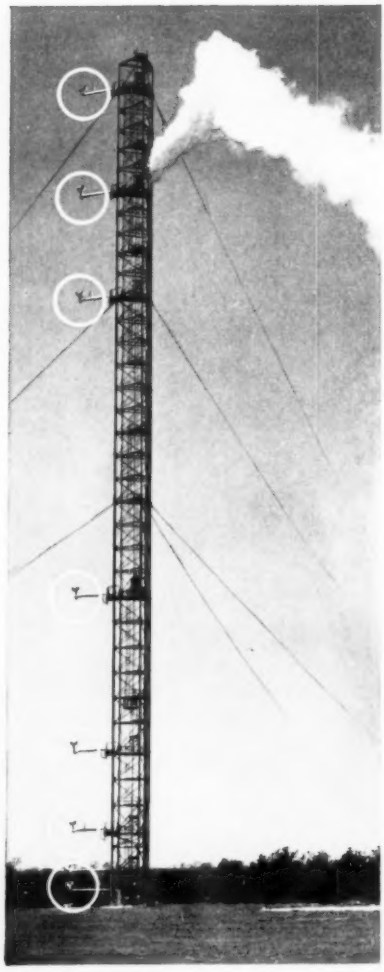

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